

**IN THE CLAIMS:**

- 1     1.     (Withdrawn) A direct oxidation fuel cell, comprising:  
2                 (A)     a membrane electrode assembly, including:  
3                         (i)     a protonically conductive, electronically non-conductive  
4                                 membrane electrolyte having an anode face and an oppos-  
5                                 ing cathode face; and  
6                         (ii)    a catalyst coating disposed upon each of said anode face  
7                                 and said cathode face, whereby electricity-generating reac-  
8                                 tions occur upon introduction of an associated fuel includ-  
9                                 ing anodic disassociation of said fuel into carbon dioxide,  
10                                protons and electrons, and a cathodic combination of pro-  
11                                tons, electrons and oxygen from an associated source of  
12                                oxygen, producing water; and  
13                 (B)     an anodic metallic diffusion layer disposed generally parallel to  
14                         said anode face of said membrane electrode assembly and having a  
15                         plurality of openings therein to allow said associated fuel mixture  
16                         to pass therethrough to said anode face of said membrane electrode  
17                         assembly to a contact point on said membrane to produce said  
18                         electricity generating reaction, and to allow free electrons and car-  
19                         bon dioxide produced in said reactions to return back away from  
20                         said membrane electrode assembly, and to allow unreacted fuel to  
21                         return back from said membrane electrode assembly;  
22                 (C)     a cathodic metallic diffusion layer disposed generally parallel to  
23                         said cathode face of said membrane electrode assembly and having  
24                         a plurality of openings therein to allow oxygen to pass there-  
25                         through to said cathode face of said membrane electrode assembly  
26                         and protons, electrons and water to pass back away from said  
27                         membrane electrode assembly; and

28 (D) a load coupled across said fuel cell providing a path for said free  
29 electrons produced in said electricity-generating reactions.

1 2. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 said openings in at least one of said anodic metallic diffusion layer and said ca-  
3 thodic metallic diffusion layer comprise a plurality of pores formed in said metallic diffu-  
4 sion layer.

1 3. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-  
3 sion layer comprise a porous metal that has said openings therein that allow substances to  
4 pass through said openings.

1 4. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 said anodic metallic diffusion layer is comprised of stainless steel.

1 5. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 said cathodic metallic diffusion layer is comprised of a material selected from the  
3 group consisting of nickel, copper, steel and combinations thereof.

1 6. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-  
3 sion layer comprises a composition of loose pieces of metal that have spaces therebe-  
4 tween allowing substances to pass between the interstices of said metal pieces.

1 7. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 further com-  
2 prising  
3 a first flow field plate disposed parallel to said anode metallic diffusion  
4 layer;

5 a second flow field plate disposed parallel said cathode metallic diffusion  
6 layer;  
7 each of said flow field plates having grooves formed therein to direct the  
8 flow of substances within said fuel cell most efficiently across its respec-  
9 tive metallic diffusion layer; and  
10 a load connected between said first flow field plate and said second flow  
11 field plate to form an electrical circuit external to said fuel to extract elec-  
12 trons, and thus electricity, from said fuel cell.

1 8. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 said anode metallic diffusion layer performs as a flow field plate to con-  
3 duct electrons produced in said electricity generating reactions and said load be-  
4 ing connected at one end to said anode metallic diffusion layer to provide a path  
5 for said electrons out of said fuel cell as the electricity produced by said fuel cell.

1 9. (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2 said cathode metallic diffusion layer performs as a flow field plate to re-  
3 unite electrons with protons that pass through said membrane and said load being  
4 attached at one end to said cathode metallic diffusion layer to reunite said elec-  
5 trons with said protons and reacting with oxygen at said cathode side of said fuel  
6 cell thus producing water.

1 10. (Withdrawn) The direct oxidation fuel cell as defined in claim 8 wherein  
2 said anode metallic diffusion layer performing as said flow field plate in-  
3 cludes grooves formed therein to direct the flow of fuel to said anode face  
4 of said membrane electrode assembly.

- 1     11.     (Withdrawn) The direct oxidation fuel cell as defined in claim 9 wherein  
2                    said cathode metallic diffusion layer performing as said flow field plate  
3                    has grooves formed therein to direct the flow of said oxygen across the  
4                    cathode face of said membrane electrode assembly.
- 1     12.     (Withdrawn) The direct oxidation fuel cell as defined in claim 1 wherein  
2                    said fuel is selected from the group consisting of methanol, ethanol, pro-  
3                    pane, butane and aqueous solutions thereof, and combinations thereof.
- 1     13.     (Withdrawn) A direct oxidation fuel cell system, comprising:  
2                    (A)     a direct oxidation fuel cell including an anode, a cathode, and a  
3     membrane electrolyte disposed between the anode and the cathode;  
4                    (B)     a source of fuel;  
5                    (C)     a source of oxygen coupled to said cathode so as to produce elec-  
6     tricity-generating reactions including anodic disassociation of said fuel to produce  
7     carbon dioxide, protons and electrons and a cathodic combination of protons,  
8     electrons and oxygen producing water;  
9                    (D)     a gas separator coupled to receive said carbon dioxide produced at  
10                    said anode;  
11                    (E)     an anodic metallic diffusion layer disposed generally parallel to  
12                    said anode face of said membrane electrode assembly and having a  
13                    plurality of openings therein to allow said associated fuel mixture  
14                    to pass therethrough to said anode face of said membrane electrode  
15                    assembly to a contact point on said membrane to produce said  
16                    electricity generating reaction, and to allow free electrons and car-  
17                    bon dioxide produced in said reactions to return back away from  
18                    said membrane electrode assembly, and to allow unreacted fuel to  
19                    return back from said membrane electrode assembly;  
20                    (F)     a cathodic metallic diffusion layer disposed generally parallel to  
21                    said cathode face of said membrane electrode assembly and having

22 a plurality of openings therein to allow oxygen to pass there-  
23 through to said cathode face of said membrane electrode assembly  
24 and protons, electrons and water to pass back away from said  
25 membrane electrode assembly; and  
26 (G) a load coupled across said fuel cell providing a path for said free  
27 electrons produced in said electricity-generating reactions.

1 14. (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2 said openings in at least one of said anodic metallic diffusion layer and said cathodic  
3 metallic diffusion layer comprise a plurality of pores formed in said metallic diffusion  
4 layer.

1 15. (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-  
3 sion layer comprise a porous metal that has said openings therein that allow substances to  
4 pass through said openings.

1 16. (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2 at least one of said anode metallic diffusion layer and said cathode metallic diffu-  
3 sion layer comprises a composition of loose pieces of metal that have spaces therebe-  
4 tween allowing substances to pass between the interstices of said metal pieces.

1 17. (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 further  
2 comprising:  
3 a first flow field plate disposed parallel to said anode metallic diffusion  
4 layer;  
5 a second flow field plate disposed parallel said cathode metallic diffusion  
6 layer;

7           each of said flow field plates having grooves formed therein to direct the  
8           flow of substances within said fuel cell most efficiently across its respec-  
9           tive metallic diffusion layer; and  
10          a load connected between said first flow field plate and said second flow  
11       field plate to form an electrical circuit external to said fuel to extract electrons,  
12       and thus electricity, from said fuel cell.

1   18.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2           said anode metallic diffusion layer performs as a flow field plate to con-  
3       duct electrons produced in said electricity generating reactions and said load be-  
4       ing connected at one end to said anode metallic diffusion layer to provide a path  
5       for said electrons out of said fuel cell as the electricity produced by said fuel cell.

1   19.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2           said cathode metallic diffusion layer performs as a flow field plate to re-  
3       unite electrons with protons that pass through said membrane and said load being  
4       attached at one end to said cathode metallic diffusion layer to reunite said elec-  
5       trons with said protons and reacting with oxygen at said cathode side of said fuel  
6       cell thus producing water.

1   20.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2           said anode metallic diffusion layer performing as said flow field plate in-  
3       cludes grooves formed therein to direct the flow of fuel to said anode face of said  
4       membrane electrode assembly.

1   21.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2           said cathode metallic diffusion layer performing as said flow field plate  
3       has grooves formed therein to direct the flow of said oxygen across the cathode  
4       face of said membrane electrode assembly.

- 1 22. (Withdrawn) The direct oxidation fuel cell system as defined in claim 13 wherein  
2 said fuel is selected from the group consisting of methanol, ethanol, pro-  
3 pane, butane and aqueous solutions thereof, and combinations thereof.
- 1 23. (Cancelled)
- 1 24. (Currently Amended) A direct oxidation fuel cell, comprising:  
2 (A) a membrane electrode assembly disposed within a fuel cell hous-  
3 ing, including  
4 (i) a protonically conductive, electronically non-conductive  
5 membrane electrolyte having an anode face and an opposing cathode face;  
6 (ii) an anodic metallic diffusion layer disposed generally par-  
7 allel to said anode face of said membrane electrode assembly and having a  
8 plurality of openings therein, said openings being of a size so as to limit  
9 mass transport of an associated fuel substance therethrough to said anode  
10 face of said membrane electrode assembly to produce electricity generat-  
11 ing reactions and to allow the mass transport of carbon dioxide produced  
12 in said reactions away from said membrane electrode assembly;  
13 (iii) an anode catalyst disposed generally between said anode  
14 face and said anodic metallic diffusion layer, and a cathode catalyst dis-  
15 posed generally between said cathode face of the protonically conductive,  
16 electronically non-conductive membrane electrolyte, and a cathode side of  
17 said housing, whereby electricity-generating reactions occur upon intro-  
18 duction of said associated fuel substance including anodic disassociation  
19 of said fuel substance into carbon dioxide, protons and electrons, and a  
20 cathodic combination of protons, electrons and oxygen from an associated  
21 source of oxygen, producing water; and  
22 (B) a load coupled across an anode and cathode of said fuel cell, pro-  
23 viding a path for said electrons produced at the anode by said electricity-  
24 generating reactions, to the cathode.

- 1 25. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein  
3 said openings in said anodic metallic diffusion layer comprise a plurality of pores  
4 formed in said anodic metallic diffusion layer.
- 1 26. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer comprises a porous metal that has openings  
3 therein to allow substances to pass through said openings.
- 1 27. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is at least partially comprised of at least one  
3 of titanium, chromium, stainless steel and other alloys, or combinations thereof.
- 1 28. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is at least partially comprised of a metallic  
3 material that does not substantially react with methanol, or other reactants and by prod-  
4 ucts of the electricity generating reactions.
- 1 29. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein  
3 said anodic metallic diffusion layer comprises a composition of pieces of metal  
4 bonded together that have spaces therebetween allowing substances to pass between the  
5 interstices formed by said spaces between metal pieces.
- 1 30. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is treated with a substance that renders at  
3 least a portion of the anodic metallic diffusion layer at least partially hydrophobic to con-  
4 trol the flow of water while allowing the flow of gases.



1 31. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is treated with a substance that renders at  
3 least a portion of the anodic metallic diffusion layer at least partially hydrophilic to en-  
4 courage the flow of at least one of fuel and water.

1 32. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is treated with a substance that renders a first  
3 portion of the layer hydrophobic and a second portion of the layer hydrophilic, to allow  
4 for the flow of water and fuel and the flow of gases in proportion to the portion that is  
5 hydrophilic and hydrophobic, respectively, throughout the anodic metallic diffusion  
6 layer.

1 33. (Previously Presented) The direct oxidation fuel cell as defined in claim 25  
2 wherein said pores are of more than one dimension.

1 34. (Previously Presented) The direct oxidation fuel cell as defined in claim 33  
2 wherein a group of said pores formed in said anodic metallic diffusion layer are of a  
3 larger size than a remaining group of said pores, and at least some of the pores of said  
4 larger size are treated with a hydrophilic material.

1 35. (Previously Presented) The direct oxidation fuel cell as defined in claim 34  
2 wherein at least some of said remaining group of pores are treated with a hydrophobic  
3 material.

1 36. (Previously Presented) The direct oxidation fuel cell as defined in claim 33  
2 wherein at least some of said pores of said layer are treated with NAFION® , or a sub-  
3 stance that renders treated pores at least partially hydrophilic.

- 1 37. (Previously Presented) The direct oxidation fuel cell as defined in claim 33  
2 wherein at least some of said pores of said layer are treated with TEFLON®, or other hy-  
3 drophobic agent to render treated pores at least partially hydrophobic.
- 1 38. (Previously Presented) The direct oxidation fuel cell as defined in claim 29  
2 wherein said pieces of metal are bonded together by particle diffusion bonding tech-  
3 niques.
- 1 39. (Previously Presented) The direct oxidation fuel cell as defined in claim 38  
2 wherein said particles are treated by at least one of a hydrophobic substance and a hydro-  
3 philic substance.
- 1 40. (Previously Presented) The direct oxidation fuel cell as defined in claim 24,  
2 wherein a first portion of said layer is treated with a hydrophobic substance, and a second  
3 portion of said layer is treated with a hydrophilic substance, to form a pattern in said me-  
4 tallic diffusion layer of areas of relative hydrophobicity and areas of relative hydrophilic-  
5 ity, to provide discrete paths through the metallic diffusion layer through which gaseous  
6 and liquid reactants and byproducts can pass.
- 1 41. (Previously Presented) The direct oxidation fuel cell as defined in claim 24, fur-  
2 ther comprising:  
3 a flow field plate disposed generally parallel to said anodic metallic diffusion  
4 layer, said flow field plate having channels formed therein to direct the flow of sub-  
5 stances within said fuel cell across said anodic metallic diffusion layer.
- 1 42. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein  
3 said anodic metallic diffusion layer performs as a flow field plate and current  
4 collector to conduct electrons produced in said electricity generating reactions and said

5 load being coupled to said anodic metallic diffusion layer to provide a path for said elec-  
6 trons out of said fuel cell as the electricity is produced by said fuel cell.

1 43. (Previously Presented) The direct oxidation fuel cell as defined in claim 42  
2 wherein

3 said anodic metallic diffusion layer performing as said flow field plate and current  
4 collector includes channels formed therein to direct the flow of fuel to said anode face of  
5 said membrane electrode assembly.

1 44. (Previously Presented) The direct oxidation fuel cell as defined in claim 24 fur-  
2 ther comprising

3 a cathodic metallic diffusion layer disposed generally parallel to said cathode face  
4 of said membrane electrode assembly and having a plurality of openings therein, said  
5 openings being sized to limit the transport of oxygen to said cathode face of said mem-  
6 brane electrode assembly, and to control water in said fuel cell.

1 45. (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2 wherein

3 said openings in said cathodic metallic diffusion layer comprise a plurality of  
4 pores formed in said cathodic metallic diffusion layer, said pores being sized to limit the  
5 water released from the cathode aspect of the fuel cell.

1 46. (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2 wherein

3 said cathodic metallic diffusion layer comprises a porous metal that has openings  
4 therein that allow substances to pass through said openings, said openings being sized to  
5 limit the water that is released from the cathode aspect of the fuel cell.

1 47. (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2 wherein

3           said cathodic metallic diffusion layer comprises a porous metal that has openings  
4   therein that allow removal of liquids from, and allow introduction of gases to the mem-  
5   brane electrode assembly.

1   48.   (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2   wherein said cathodic metallic diffusion layer is at least in part comprised of a material  
3   selected from the group consisting of nickel, copper, titanium, chromium, steel, stainless  
4   steel, and other alloys and combinations thereof.

1   49.   (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2   wherein said cathodic metallic diffusion layer is at least in part comprised of a material  
3   that does not substantially react with byproducts or substances, present on the cathode of  
4   the fuel cell.

1   50.   (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2   wherein  
3           said cathodic metallic diffusion layer comprises a composition of pieces of metal  
4   bonded together that have spaces therebetween allowing substances to pass through the  
5   interstices formed by said spaces between said metal pieces, the spaces being sized to  
6   control the flow of water in said fuel cell.

1   51.   (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2   wherein said cathodic metallic diffusion layer is treated with a substance that renders the  
3   layer at least partially hydrophobic, to allow the introduction of gases to the membrane  
4   electrode assembly.

1   52.   (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2   wherein said cathodic metallic diffusion layer is treated with a substance that renders the  
3   layer at least partially hydrophilic, to allow the removal of liquids from the cathode face  
4   of the membrane electrode assembly.

1 53. (Currently Amended) The direct oxidation fuel cell as defined in claim 44  
2 wherein said cathodic metallic diffusion layer is treated with a first substance that renders  
3 a first portion of the cathodic metallic diffusion layer hydrophobic and a second sub-  
4 stance that renders a second portion of the cathodic metallic diffusion layer hydrophilic,  
5 to balance the flow of water and the flow of gases throughout the cathodic metallic diffu-  
6 sion layer.

1 54. (Previously Presented) The direct oxidation fuel cell as defined in claim 44 fur-  
2 ther comprising a second flow field plate that is disposed generally parallel to said ca-  
3 thodic metallic diffusion layer.

1 55. (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2 wherein  
3 said cathodic metallic diffusion layer performs as a flow field plate and current  
4 collector, and said load being coupled to said cathodic metallic diffusion layer to provide  
5 a path for electrons to travel to the cathode where it combines with oxygen at said cath-  
6 ode side of said fuel cell, producing water.

1 56. (Previously Presented) The direct oxidation fuel cell as defined in claim 55  
2 wherein  
3 said cathodic metallic diffusion layer performing as said flow field plate and cur-  
4 rent collector has channels formed therein to direct the flow of oxygen across the cathode  
5 face of said membrane electrode assembly.

1 57. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is at least in part comprised of a material  
3 having properties that improve conductivity.

- 1 58. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said anodic metallic diffusion layer is treated or coated with a material to provide  
3 improved conductivity.
- 1 59. (Previously Presented) The direct oxidation fuel cell as defined in claim 44  
2 wherein said cathodic metallic diffusion layer is at least in part comprised of a material  
3 having properties that improve conductivity.
- 1 60. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein said cathodic metallic diffusion layer is treated or coated with a material to pro-  
3 vide improved conductivity.
- 1 61. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein  
3 said fuel substance is a liquid carbonaceous fuel substance.
- 1 62. (Previously Presented) The direct oxidation fuel cell as defined in claim 24  
2 wherein  
3 said fuel substance is selected from the group consisting of methanol, ethanol,  
4 propanol, butanol and aqueous solutions thereof and combinations thereof.
- 1 63. (Withdrawn) A direct oxidation fuel cell system, comprising:  
2 (A) a direct oxidation fuel cell including an anode, a cathode, and a membrane  
3 electrode assembly including a catalyzed membrane disposed between the  
4 anode and the cathode;  
5 (B) a catalyst in proximity to said membrane electrolyte;  
6 (C) a source of fuel in communication with the anode;  
7 (D) a source of oxygen in communication with said cathode so as to produce  
8 electricity-generating reactions including anodic disassociation of said fuel

- 9                   to produce carbon dioxide, protons and electrons and a cathodic combina-  
10                   tion of protons, electrons and oxygen producing water;
- 11           (E)     an anodic metallic diffusion layer disposed generally parallel to said anode  
12                   of said membrane electrode assembly and having a plurality of openings  
13                   therein to allow a fuel substance to pass therethrough to said anode of said  
14                   membrane electrode assembly to produce said electricity generating reac-  
15                   tions, and to allow electrons and carbon dioxide produced in said reactions  
16                   to travel away from said membrane electrode assembly; and
- 17           (F)     a load coupled across said anode and cathode of said fuel cell, providing a  
18                   path for said electrons produced at the anode by said electricity-generating  
19                   reactions, to the cathode.

1   64.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 63, further  
2   comprising a liquid/gas separator coupled to separate gaseous products of the anodic re-  
3   action from any liquids present.

1   65.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 63,  
2   wherein said openings in said anodic metallic diffusion layer comprise a plurality of  
3   pores formed in said anodic metallic diffusion layer.

1   66.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 63 wherein  
2           said anodic metallic diffusion layer comprises a porous metal that has openings  
3   therein that allows substances to pass through said openings.

1   67.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 63 wherein

2       said anodic metallic diffusion layer comprises a composition of loose pieces of  
3 metal bonded together that have spaces therebetween allowing substances to pass through  
4 the interstices formed by the spaces between said metal pieces.

1   68.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 63 further  
2 comprising:

3       (A)   a flow field plate disposed generally parallel to said anodic metallic diffu-  
4           sion layer;

5       (B)   a second flow field plate disposed generally parallel to said cath-  
6           ode face of said membrane electrode assembly, and each of said first and second  
7           flow field plates having channels formed therein to direct the flow of substances  
8           within said fuel cell across its respective metallic diffusion layers; and

9       (C)   a load coupled between said first flow field plate and said second flow  
10           field plate to form an electrical circuit through which electrical current  
11           generated by the fuel cell system may flow.

1   69.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 63 wherein  
2 said anodic metallic diffusion layer performs as a flow field plate and current collector to  
3 conduct electrons produced in said electricity generating reactions and said load being  
4 coupled to said anodic metallic diffusion layer to provide a path for said electrons away  
5 from said anode.

1   70.   (Withdrawn) The direct oxidation fuel cell system as defined in claim 69 wherein  
2       said anodic metallic diffusion layer performing as said flow field plate and current  
3 collector includes channels formed therein to direct the flow of fuel to said anode face of  
4 said membrane electrode assembly.



- 1    71.    (Withdrawn) A direct oxidation fuel cell, comprising:  
2            (A)    a membrane electrode assembly disposed within a fuel cell housing, in-  
3                    cluding:  
4                    (i)    a protonically conductive, electronically non-conductive  
5                            membrane electrolyte having an anode face and an opposing cath-  
6                            ode face;  
7                    (ii)    a cathodic metallic diffusion layer disposed generally par-  
8                            allel to said cathode face of said membrane electrode assembly and having  
9                            a plurality of openings therein to allow oxygen to pass therethrough to said  
10                           cathode face of said membrane electrode assembly and protons, electrons  
11                           and water to travel away from said membrane electrode assembly;  
12                    (iii)    an anode catalyst disposed generally between said anode  
13                           face and an anode side of said housing, and a cathode catalyst disposed generally  
14                           between said cathode face and said cathodic metallic diffusion layer, whereby  
15                           electricity-generating reactions occur upon introduction of said associated fuel  
16                           substance including anodic disassociation of said fuel substance into carbon di-  
17                           oxide, protons and electrons, and a cathodic combination of protons, electrons and  
18                           oxygen from an associated source of oxygen, producing water; and  
19            (B)    a load coupled across the anode and cathode of said fuel cell, providing a  
20                    path for said electrons produced at the anode by said electricity-generating  
21                    reactions, to the cathode.
- 1    72.    (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2            said openings in said cathodic diffusion layer comprise a plurality of pores formed  
3            in said cathodic metallic diffusion layer.
- 1    73.    (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein

2           said cathodic metallic diffusion layer comprises a porous metal that has openings  
3   therein that allows substances to pass through said openings.

1   74.   (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2           said cathodic metallic diffusion layer is at least in part comprised of a material  
3   selected from the group consisting of nickel, copper, titanium, chromium steel, stainless  
4   steel, and other suitable alloys and combinations thereof.

1   75.   (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2           said cathodic metallic diffusion layer is at least in part comprised of a material  
3   that does not substantially react with byproducts or substances, present on the cathode of  
4   the fuel cell.

1   76.   (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2           said cathodic metallic diffusion layer comprises a composition of loose pieces of  
3   metal bonded together that have spaces therebetween allowing substances to pass through  
4   the interstices formed by the spaces between said metal pieces.

1   77.   (Withdrawn) The direct oxidation fuel cell as defined in claim 71 wherein said  
2   cathodic metallic diffusion layer is treated with a substance that renders the layer at least  
3   partially hydrophobic.

1   78.   (Withdrawn) The direct oxidation fuel cell as defined in claim 71 wherein said  
2   cathodic metallic diffusion layer is treated with a substance that renders the layer at least  
3   partially hydrophilic.

1 79. (Withdrawn) The direct oxidation fuel cell as defined in claim 71 wherein said  
2 cathodic metallic diffusion layer is treated with a substance that renders a first portion of  
3 the layer hydrophobic and a second portion of the layer hydrophilic.

1 80. (Withdrawn) The direct oxidation fuel cell as defined in claim 72 wherein said  
2 pores are of more than one dimension.

1 81. (Withdrawn) The direct oxidation fuel cell as defined in claim 72 wherein a group  
2 of said pores formed in said cathodic metallic diffusion layer are of a larger size than a  
3 remaining group of said pores, and at least some of the pores of said larger size are  
4 treated with a hydrophilic material.

1 82. (Withdrawn) The direct oxidation fuel cell as defined in claim 81 wherein at least  
2 some of said remaining group of pores are treated with a hydrophobic material.

1 83. (Withdrawn) The direct oxidation fuel cell as defined in claim 72 wherein at least  
2 some of said pores of said layer are treated with Nafion, or a substance that renders  
3 treated pores at least partially hydrophilic.

1 84. (Withdrawn) The direct oxidation fuel cell as defined in claim 72 wherein at least  
2 some of said pores of said layer are treated with Teflon, or other hydrophobic agent to  
3 render treated pores at least partially hydrophobic.

1 85. (Withdrawn) The direct oxidation fuel cell as defined in claim 71 wherein said  
2 loose pieces of metal are bonded together by particle diffusion bonding techniques.

1 86. (Withdrawn) The direct oxidation fuel cell as defined in claim 71 wherein said  
2 particles are treated by at least one of a hydrophobic substance and a hydrophilic sub-  
3 stance.

1 87. (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein a first  
2 portion of said layer is treated with a hydrophobic substance, and a second portion of said  
3 layer is treated with a hydrophilic substance, to form a pattern in said diffusion layer of  
4 areas of relative hydrophobicity and areas of relative hydrophilicity, to provide discrete  
5 paths through the metallic diffusion layer through which gaseous and liquid reactants and  
6 byproducts can pass.

1 88. (Withdrawn) The direct oxidation fuel cell as defined in claim 71, further com-  
2 prising:  
3 a flow field plate disposed generally parallel to said cathodic metallic dif-  
4 fusion layer, said flow field plates having channels formed therein to direct the flow of  
5 substances within said fuel cell across the cathodic metallic diffusion layer.

1 89. (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2 said cathodic metallic diffusion layer performs as a flow field plate and current  
3 collector to reunite said electrons with protons that pass through said membrane and said  
4 load being coupled to said cathodic metallic diffusion layer to reunite said electrons with  
5 said protons and react with oxygen at said cathode side of said fuel cell thus producing  
6 water.

1 90. (Withdrawn) The direct oxidation fuel cell as defined in claim 89, wherein  
2 said cathodic metallic diffusion layer performing as said flow field plate and cur-  
3 rent collector has channels formed therein to direct the flow of said oxygen across the  
4 cathode face of said membrane electrode assembly.

1 91. (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2 said fuel substance is a liquid carbonaceous fuel substance.

1 92. (Withdrawn) The direct oxidation fuel cell as defined in claim 71, wherein  
2 said fuel substance is selected from the group consisting of methanol, ethanol,  
3 propanol, butanol and aqueous solutions thereof and combinations thereof.

1 93. (Withdrawn) A direct oxidation fuel cell system, comprising:  
2 (A) a direct oxidation fuel cell including an anode, a cathode, and a membrane  
3 electrode assembly disposed between the anode and the cathode;  
4 (B) a catalyst in proximity to said membrane electrolyte;  
5 (C) a source of fuel in communication with the anode;  
6 (D) a source of oxygen in communication with said cathode so as to produce  
7 electricity-generating reactions including anodic disassociation of said fuel  
8 to produce carbon dioxide, protons and electrons and a cathodic combina-  
9 tion of protons, electrons and oxygen producing water;  
10 (E) a cathodic metallic diffusion layer disposed generally parallel to said cath-  
11 ode face of said membrane electrode assembly and having a plurality of  
12 openings therein to allow oxygen to pass therethrough to said cathode face  
13 of said membrane electrode assembly and protons, electrons and water to  
14 travel away from said membrane electrode assembly; and

15           (F)     a load coupled across the anode and the cathode of said fuel cell, provid-  
16                    ing a path for said electrons produced at the anode by said electricity-  
17                    generating reactions, to the cathode.

1     94.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 93, further  
2     comprising:  
3             a liquid/gas separator coupled to separate gaseous products of the anodic reaction  
4     from any liquids present.

1     95.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2     wherein  
3             said openings in said cathodic metallic diffusion layer comprise a plurality of  
4     pores formed in said cathode metallic diffusion layer.

1     96.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2     wherein said cathode metallic diffusion layer comprises a porous metal that has openings  
3     therein that allow substances to pass through said opening.

1     97.     (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2     wherein  
3             said cathode metallic diffusion layer comprises a composition of loose pieces of  
4     metal bonded together that have spaces therebetween allowing substances to pass through  
5     the interstices formed by said spaces between said metal pieces.

1 98. (Withdrawn) The direct oxidation fuel cell system as defined in claim 93, further  
2 comprising:

- 3 (A) a first flow field plate disposed generally parallel to said anode face of  
4 said membrane electrode assembly;
- 5 (B) a second flow field plate disposed generally parallel to said cathode me-  
6 tallic diffusion layer, each of said flow field plates having channels formed  
7 therein to direct the flow of substances within said fuel cell; and
- 8 (C) a load coupled between said first flow field plate and said second flow  
9 field plate to form an electrical circuit external to said fuel to extract elec-  
10 trons, and thus electricity from said fuel cell.

1 99. (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2 wherein said cathode metallic diffusion layer performs as a flow field plate and current  
3 collector to reunite electrons with protons that pass through said membrane and said load  
4 being coupled to said cathode metallic diffusion layer to reunite said electrons with said  
5 protons and react with oxygen.

1 100. (Withdrawn) The direct oxidation fuel cell system as defined in claim 99,  
2 wherein said cathodic metallic diffusion layer performing as said flow field plate and cur-  
3 rent collector has channels formed therein to direct the flow of oxygen across the cathode  
4 face of said membrane electrode assembly.

1 101. (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2 wherein  
3 said fuel is a liquid carbonaceous fuel.

1 102. (Withdrawn) The direct oxidation fuel cell system as defined in claim 93,  
2 wherein

3 said fuel is selected from the group consisting of methanol, ethanol, propanol,  
4 butanol and aqueous solutions thereof, and combinations thereof.

1 103. (Withdrawn) The direct oxidation fuel cell system as defined in claim 93 wherein  
2 said cathodic metallic diffusion layer has openings therein that allow removal of liquids  
3 from, and allow the introduction of gases to the membrane electrode assembly.

1 104. (Withdrawn) A direct oxidation fuel cell system comprising:

2 (A) a direct oxidation fuel cell means including a membrane electrode assem-  
3 bly having an anode, a cathode and a protonically conductive, electroni-  
4 cally non-conductive membrane electrolyte disposed between the anode  
5 and the cathode;

6 (B) means for providing a fuel substance to said fuel cell;

7 (C) means for providing oxygen to said cathode of said membrane electrode  
8 assembly so as to produce electricity-generating reactions including ca-  
9 thodic combination of protons, electrons and oxygen producing water; and

10 (D) means for distributing said fuel substance generally evenly to said anode  
11 of said membrane electrode assembly so as to produce electricity-  
12 generating reactions including anodic disassociation of said fuel substance  
13 to produce carbon dioxide, protons and electrons.

1 105. (Withdrawn) The direct oxidation fuel cell system as defined in claim 104, fur-  
2 ther comprising a means for distributing said oxygen generally evenly to said cathode and  
3 said means for distributing said oxygen.



1 106. (Withdrawn) The direct oxidation fuel cell system as defined in claim 104, fur-  
2 ther comprising said means for distributing said fuel substance being of a substantially  
3 metallic composition.

1 107. (Withdrawn) The direct oxidation fuel cell system as defined in claim 104, fur-  
2 ther comprising a means for allowing gaseous products of the anodic reaction to be re-  
3 moved from the membrane electrode assembly.

1 108. (Withdrawn) The direct oxidation fuel cell system as defined in claim 104, fur-  
2 ther comprising a means for allowing fluid byproducts of the cathodic reaction to be re-  
3 moved from the membrane electrode assembly.

1 109. (Withdrawn) The direct oxidation fuel cell system as defined in claim 104,  
2 wherein said means for distributing said oxygen being substantially comprised of a me-  
3 tallic composition.

1 110. (Withdrawn) A means for generating electricity comprising:  
2 (A) a direct oxidation fuel cell means including a membrane electrode assem-  
3 bly having an anode, a cathode, and a protonically conductive electroni-  
4 cally non-conductive membrane electrolyte disposed between said anode  
5 and said cathode;  
6 (B) means for providing oxygen coupled to said cathode so as to produce  
7 electricity-generating reactions including anodic disassociation of a fuel

- 8 substance to produce carbon dioxide, protons and electrons and a cathodic  
9 combination of protons, electrons and oxygen producing water;
- 10 (C) means for providing said fuel substance to said fuel cell
- 11 (D) means for distributing oxygen generally evenly to said cathode; and
- 12 (E) means for coupling the anode to the cathode.

1 111. (Previously Presented) The direct oxidation fuel cell as defined in claim 24 further  
2 comprising:

- 3 an additional layer, disposed between said anodic metallic diffusion layer  
4 and said anode catalyst, of at least one of the following:
- 5 (i) carbon paper; and
- 6 (ii) carbon cloth.

1 112. (Previously Presented) The direct oxidation fuel cell as defined in claim 44 further  
2 comprising:

- 3 an additional layer, disposed between said cathodic metallic diffusion  
4 layer and said cathode catalyst, of at least one of the following:
- 5 (i) carbon paper; and
- 6 (ii) carbon cloth.

113. (Previously Presented) The direct oxidation fuel cell as defined in claim 44 wherein  
said cathodic metallic component is substantially hydrophilic.